LAWRENCE
LIVERMORE
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LABORATORY

UCRL-TR-230742

Lattice QCD Thermodynamcis : P4 Action for new beta and MILC Nt=6

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May 7, 2007

This work was performed under the auspices of the U.S. Department of Energy by University of California, Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.

Lattice QCD Thermodynamics
P4 New Beta Analysis and MILC nt=6

Background

These results are from the continuing Lattice Quantum Chromodynamics runs on BG/L. We show analyzed thermodynamics results for 6–10k trajectories (β dependent), of th e32^3x8 runs with the p4rhmc v2.0 QMP_MPI.X (semi-optomized p4 code using qmp over mpi). These jobs had a number of omitted trajectories, due to zero size and over-sized data files. For this interim report these errors were removed from the output to save space. The results also include the output of a new "histogram.perl" script, used to plot the gauge action $< S_g >= 10*(1- < plaq >)-(1- < rect >)$ for three values of β=3.51, 3.54, 3.57. This output will be used to determine the new β values that will be run to define the critical temperature.

We also show a preliminary analysis on the first 5,000 trajectories of the 32^3x6 runs for the milc code, using the new su3_rhmc_susc_eos.3g1f.qmp-bgl2 faster RHMC algorithm.

P4RHMC Histrogram

```
1: 390:2.6375 1
2: 388:2.6625 1
3: 395:2.6875 1
4: 391:3.2775 1
5: 385:3.3075 1
6: 388:3.3375 1
7: 387:3.5075 1
8: 390:3.5375 1
9: 393:3.5675 1
10: 388:3.6075 1
11: 387:3.6425 1
12: 391:3.6725 2
13: 384:3.7025 1
14: 389:3.7075 1
15: 391:3.7275 1
16: 392:3.7375 1
17: 389:3.7425 2
18: 394:3.7575 1
19: 391:3.7625 2
20: 392:3.7725 2
21: 393:3.7825 2
22: 397:3.7875 1
23: 393:3.7925 1
24: 403:3.7975 6
25: 385:3.8025 1
26: 393:3.8075 4
27: 389:3.8125 4
28: 439:3.8175 10
29: 394:3.8225 8
30: 447:3.8275 17
31: 500:3.8325 197
32: 558:3.8375 3874
```

```
33: 554:3.8425 3928
34: 498:3.8475 144
35: 394:3.8525 5
36: 401:3.8575 7
37: 393:3.8625 3
38: 400:3.8675 5
39: 446:3.8725 16
40: 451:3.8775 34
41: 498:3.8825 253
42: 549:3.8875 3311
43: 554:3.8925 3824
44: 507:3.8975 382
45: 392:3.9025 7
46: 394:3.9075 4
47: 392:3.9125 6
48: 443:3.9175 13
49: 394:3.9225 7
50: 445:3.9275 23
51: 448:3.9325 75
52: 507:3.9375 495
53: 549:3.9425 3823
54: 556:3.9475 2952
55: 497:3.9525 164
```

P4RHMC Analysis

```
1: 777:p4b3.46 10 250
2: 3783:gauge 4670 4.043636143 0.0001001991319 7.07118836e-06 3.406184733e-07
3: 2405:hmc 4670 2.433193981 1.025896582 0.5171531873
4: 562:pbp 9340
5: 3594:0.00313 0.07334155993 9.078655385e-05 2.431281847e-06 2.527121736e-07
6: 3564:0.03130 0.1553570219 5.699341156e-05 1.278484954e-06 9.879415169e-08
7: 3855:plaq 4670 0.5240303533 1.154799878e-05 9.196380114e-08 4.494211011e-09
8: 3900:rect 4670 0.2839396761 1.579772317e-05 1.598258344e-07 8.080874609e-09
9: 4024:wline 18680 0.004271352045 0.0002640940765 8.78351579e-05 2.927009049e-06
10: 0:
11: 780:p4b3.49 10 250
12: 3868:gauge 6040 3.98279412 9.384541249e-05 7.762934575e-06 2.906027217e-07
13: 2381:hmc 6040 1.883441801 1.050367615 0.5829441134
14: 605:pbp 12080
15: 3417:0.0029 0.05336202244 0.0001043314059 5.387915508e-06 3.39732408e-07
16: 3484:0.0290 0.1318711133 6.008574797e-05 1.961305278e-06 1.104809367e-07
17: 3855:plaq 6040 0.5309711369 1.084770533e-05 1.016662345e-07 3.855547254e-09
18: 3886:rect 6040 0.2925054887 1.497927464e-05 1.821992469e-07 7.211944175e-09
19: 4070:wline 24160 0.007502288789 0.0002243853143 8.981448024e-05 2.601787135e-06
20: 0:
21: 773:p4b3.51 10 250
22: 3881:gauge 7540 3.944380883 7.710148972e-05 6.942829738e-06 2.76147056e-07
23: 2418:hmc 7540 1.638221059 1.008296488 0.5863786594
```

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24: 608:pbp 15080
25: 3401:0.02590 0.113064149 4.740043931e-05 1.531182273e-06 1.04495003e-07
26: 3587:0.00259 0.04011730832 8.622681421e-05 4.694493245e-06 3.267266491e-07
27: 3913:plaq 7540 0.5353569994 8.922288626e-06 9.097252965e-08 3.692535178e-09
28: 3868:rect 7540 0.2979508773 1.247517801e-05 1.656016072e-07 7.193828303e-09
29: 4020:wline 30160 0.01184494319 0.0001996236161 9.169241538e-05 2.160931787e-06
30: 0:
31: 776:p4b3.54 10 250
32: 3938:gauge 7560 3.890382227 7.191551401e-05 6.524866699e-06 2.169799449e-07
33: 2385:hmc 7560 1.280830522 1.008567627 0.6194032173
34: 603:pbp 15120
35: 3528:0.0024 0.02158232421 9.060769197e-05 5.722937525e-06 2.823820017e-07
36: 3574:0.0240 0.09327485875 4.949644921e-05 1.717937506e-06 8.775121958e-08
37: 3879:plaq 7560 0.5415250794 8.324192128e-06 8.546562951e-08 2.881526526e-09
38: 3799:rect 7560 0.3056330212 1.170328537e-05 1.56681368e-07 5.472666213e-09
39: 4015:wline 30240 0.02263052062 0.0002094921052 9.776049483e-05 2.378158959e-06
40: 0:
41: 779:p4b3.57 10 250
42: 3896:gauge 8130 3.840031197 6.223651316e-05 5.934321196e-06 1.689417517e-07
43: 2386:hmc 8130 1.065737489 1.024280409 0.6632423163
44: 609:pbp 16260
45: 3568:0.00212 0.01079382323 4.073461834e-05 1.259147008e-06 7.039108463e-08
46: 3521:0.02120 0.0741339525 3.730442555e-05 1.055398491e-06 5.310519353e-08
47: 3878:plaq 8130 0.5472776212 7.198406931e-06 7.755097674e-08 2.237215625e-09
48: 3748:rect 8130 0.3128074083 1.0110237e-05 1.420981469e-07 4.298599037e-09
49: 3916:wline 32520 0.0339239975 0.0002136834425 0.0001061295858 2.562049844e-06
50: 0:
51: 773:p4b3.60 10 250
52: 3919:gauge 9950 3.794140077 5.211569542e-05 5.466228027e-06 1.359275199e-07
53: 2465:hmc 9950 0.9487616756 1.011364822 0.6779153524

54: 613:pbp 19900
55: 3618:0.01920 0.06139367996 2.260681998e-05 4.736242736e-07 2.186208476e-08
56: 3646:0.00192 0.007124847053 1.425882001e-05 1.899984413e-07 1.488062948e-08
57: 3834:plaq 9950 0.552517242 6.019591584e-06 7.122901689e-08 1.792726907e-09
58: 3860:rect 9950 0.3193124962 8.411006074e-06 1.292268523e-07 3.338336627e-09
59: 3915:wline 39800 0.04283663471 0.0001902472677 0.000104569656 2.078353126e-06
60: 0:
61: 776:p4b3.63 10 250
62: 3905:gauge 9880 3.750233319 5.341492821e-05 5.431765505e-06 1.437350947e-07
63: 2479:hmc 9880 0.8979784082 1.039578054 0.6935725412
64: 617:pbp 19760
65: 3511:0.0017 0.00539601066 8.657048378e-06 6.972723911e-08 7.95591238e-09
66: 3441:0.0170 0.05043220658 2.015920482e-05 3.7938346e-07 1.696772668e-08
67: 3889:plaq 9880 0.5575316001 6.182448671e-06 7.115898987e-08 1.920079442e-09
68: 3887:rect 9880 0.3255493193 8.737217713e-06 1.331730898e-07 3.829309931e-09
69: 3865:wline 39520 0.05141171523 0.000202587449 0.0001116893788 2.37175955e-06
70: 0:
71: 779:p4b3.66 10 250
72: 3839:gauge 9300 3.708566471 5.320625191e-05 5.209093001e-06 1.46708882e-07
```

```
73: 2447:hmc 9300 0.8423276093 1.015603612 0.6876358746
74: 609:pbp 18600
75: 3588:0.0017 0.004918201107 5.122569214e-06 2.286746794e-08 2.376245573e-09
76: 3552:0.0170 0.04734720366 1.494577417e-05 1.947678107e-07 9.083428233e-09
77: 3847:plaq 9300 0.5622901469 6.17475974e-06 6.858378744e-08 1.954509067e-09
78: 3887:rect 9300 0.3314679404 8.886497742e-06 1.325629762e-07 3.848226526e-09
79: 3975:wline 37200 0.05935368159 0.0002045273713 0.0001075446798 2.462476756e-06
80: 0:
81: 782:p4b3.69 10 250
82: 3923:gauge 9880 3.668083602 4.732982163e-05 4.813464471e-06 1.130798739e-07
83: 2467:hmc 9880 0.8045379944 1.016531519 0.6928631448
84: 617:pbp 19760
85: 3559:0.0150 0.03972691017 1.033741797e-05 9.883681274e-08 4.694557431e-09
86: 3547:0.0015 0.00404668724 2.838981632e-06 7.490350955e-09 1.481105694e-09
87: 3669:plaq 9880 0.566917633 5.47525681e-06 6.3035248e-08 1.503341853e-09
88: 3881:rect 9880 0.3372599321 7.769967903e-06 1.187454443e-07 3.014306333e-09
89: 3919:wline 39520 0.06738951258 0.0002072184506 0.0001123083497 2.26695952e-06
90: 0:
91: 780:p4b3.76 10 250
92: 3901:gauge 9890 3.578902032 4.394741079e-05 4.556250791e-06 1.010045165e-07
93: 2469:hmc 9890 0.7465373552 1.023894776 0.7141569325
94: 619:pbp 19780
95: 3594:0.01390 0.03357565546 5.790357274e-06 3.066149138e-08 1.508290213e-09
96: 3623:0.00139 0.003381712016 1.178075782e-06 1.284174609e-09 2.236736405e-10
97: 3902:plaq 9890 0.5771188829 5.099545601e-06 5.996600483e-08 1.338729415e-09
98: 3875:rect 9890 0.3500908609 7.405625708e-06 1.178646951e-07 2.667033026e-09
99: 3849:wline 39560 0.084992141 0.0002105073323 0.0001174569812 2.625651192e-06
```

MILC Analysis

MILC NT=6 analysis results will go here.

```
1: 0:
2: 0 :
3: 0 :
4: 1630:nt6  (m_{u,d} = 0.lms)
5: 0 :
6:46808:beta mud ms uO ns nt ReP dReP chi_L dchi_L cgiters dcgiters pbp_ud dpbp_ud pbp_s
dpbp_s plaq dplaq rect drect pgm dpgm pb_dmdu_p_ud dpb_dmdu_p_ud pb_dmdu_p_s
dpb_dmdu_p_s chi_pbp_d dchi_pbp_d chi_pbp_c dchi_pbp_c chi_pbp_t dchi_pbp_t chi_pbp_s
dchi_pbp_s chi_pbps_d dchi_pbps_d chi_pbps_c dchi_pbps_c chi_pbps_t dchi_pbps_t chi_pbp_ss
dchi_pbp_ss chi_II dchi II chi_Oud dchi_Oud chi_s dchi_s chi_BB dchi_BB chi_YY dchi_YY chi_YB
dchi_YB D_11 dD_11 D_ss dD_ss D_ls dD_ls C_ss dC_ss dS1 ddS1 dt accept N file
7:26695:6.4000 0.00909 0.0909 0.8520 32 6 0.0201 0.0001 0.082 0.003 0.0 0.0 0.088803 0.000130
0.218129 0.000070 1.580650 0.000033 0.815044 0.000044 0.832938 0.000051 -4.89930 0.00012
-4.83325 0.00012 0.94940 0.05160 1.15910 0.00120 2.10850 0.05200 3.2676 0 0.05230 0.28790
0.01600 0.62190 0.00020 0.90980 0.01610 1.53170 0.016 10 0.1663 0.0011 0.4417 0.1404 0.1379
0.0050 0.0799 0.0248 0.0994 0.012 6 0.02412 0.01548 -0.05580 0.03564 -0.0086 0.0050 -0.0252
0.0083 0.1465 0.0011 4.87e-03 7.20e-03 0.03850 0.77 7210
o326f21b640m00909m0909r.00100_07410.strip
```

```
8:26686:6.4300 0.00862 0.0862 0.8535 32 6 0.0268 0.0003 0.090 0.003 0.0 0.0 0.074246 0.000230
 0.201645 0.000120 1.592940 0.000051 0.830583 0.000073 0.849516 0.000082 -4.89991 0.00020
 -4.84116 0.00020 1.27010 0.13420 1.23300 0.00270 2.50310 0.13530 3.7360 0 0.13640 0.35120
 0.03130 0.64580 0.00030 0.99700 0.03140 1.64270 0.031 60 0.2138 0.0018 0.8237 0.1116 0.1760
 0.0068 0.1552 0.0180 0.1386 0.012 6 0.05616 0.01296 -0.00756 0.02844 -0.0241 0.0065 -0.0173
 0.0076 0.2002 0.0018 1.64e-02 1.20e-02 0.04170 0.69 7070
 o326f21b643m00862m0862r.00040_07270.strip
9:26855:6.4580 0.00820 0.0820 0.8549 32 6 0.0351 0.0003 0.103 0.005 0.0 0.0 0.060436 0.000240
0.186425 0.000120 1.604060 0.000052 0.844762 0.000071 0.864624 0.000080 -4.89889 0.00017
-4.84678 0.00018 1.38840 0.08820 1.32100 0.00380 2.70940 0.08790 4.0304 0 0.08780 0.33840
0.02430 0.66940 0.00040 1.00780 0.02420 1.67710 0.024 10 0.2678 0.0025 0.9774 0.1008 0.2437
0.0076 0.1861 0.0176 0.1800 0.009 0 0.06012 0.01188 -0.02340 0.02556 -0.0234 0.0068 -0.0259
0.0076 0.2671 0.0022 -4.14e-03 8.40e-03 0.04170 0.75 6260
o326f21b6458m00820m0820r.00100_06460.strip
10:26815:6.4800 0.00791 0.0791 0.8560 32 6 0.0437 0.0009 0.123 0.019 0.0 0.0 0.049483 0.000510
0.174870 0.000250 1.612750 0.000086 0.855914 0.000110 0.876349 0.000140 -4.89763 0.00027
-4.85001 0.00030 1.19340 0.25320 1.39490 0.00740 2.58830 0.25140 3.9832 0 0.24980 0.29550
0.04910 0.68810 0.00100 0.98360 0.04860 1.67160 0.048 10 0.3161 0.0043 1.1837 0.2196 0.3089
0.0176 0.2189 0.0396 0.2315 0.019 1 0.07272 0.02556 -0.02016 0.05400 -0.0245 0.0180 -0.0446
0.0180 0.3334 0.0065 3.58e-02 1.70e-02 0.04170 0.77 1015
o326f21b648m00791m0791r.00100_01215.strip
11:26762:6.5000 0.00765 0.0765 0.8570 32 6 0.0534 0.0004 0.115 0.006 0.0 0.0 0.039239 0.000310
0.164006 0.000160 1.620580 0.000054 0.866038 0.000084 0.887110 0.000087 -4.89620 0.00015
-4.85285 0.00020 1.36230 0.13740 1.44580 0.00240 2.80820 0.13810 4.2540 0 0.13890 0.42850
0.03870 0.70700 0.00060 1.13550 0.03910 1.84250 0.039 60 0.3629 0.0022 1.3280 0.0612 0.3942
0.0054 0.2758 0.0112 0.2534 0.006 8 0.06372 0.00684 -0.03096 0.01548 -0.0158 0.0050 -0.0169
0.0061 0.4097 0.0032 6.3ge-03 6.60e-03 0.04170 0.80 6325
o326f21b650m00765m0765r.00100 06525.strip
```